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**EUROPEAN PATENT APPLICATION** PROPILE desent avec desentation (1994). The first contraction of the published in accordance with Art. 158(3)-EPO (desentation of the contraction cap wells to particular the present invarion relates to an improvement of corresión ros stance lo parter al secure

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(21) Application number: 03733478.6 Tuber 03/33476.0 (22) Date of filling: 18.06.2003 Marston bedought over the delivery of the property of the pro done with increase of crude oil price and anticipated all resource depiction in the user future. These oil troth and g The refer a configuration of the state of th പാട് പോട്ടാൻ ഉപയോഗ്യ വേഗ്യ വിശ്യാത്രമായിരുന്നു. segia leeps yiganWO\_2004/001,082-(31,12,2003,Gazette 2004/01),

:(84):iDesignated:Contracting:States::elmsi: oitizneham SAT BE BG CH CY CZ DE DK EE ES FI FR GB GR HUIE IT LI LU MONINERT ROSSE SISKITRO 200 erosion resistance. Ununrunately the two-phase stainless - (30) sPriority: v49.06:2002s JPs:2002178974; tort anti-naubs #300401. 150Vbe18.04:2003( JRo20031.14775idaxtow for bo anoon retailur 02.06:20035 JR::2003;156234;a aantriata oi having a st, **keldey, s** a divertime **:REP: (74)** . Representative: Grünecker, Kinkeldey, a a divertime in their hard in the mass (7.1) Applicant: JFE Steel Corporations vibrations bearing Tokyo, 100-0011 (JP)

resis and chave been proposed in for autarothevila (72). ted: \* KIMURA; Mitsuo, c/o JRE'STEEL CORRORATION: 20148 | 364 | noticalitable value metal. Trans November 2014 Chiyoda-ku, Tokyo 100-0011 (JP)

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-(54) STAINLESS STEEL PIPE FOR OIL WELL AND PROCESS FOR PRODUCING THE SAME 9 OF 13%-Qr martensitic starpless steel pige, the C content is limited to the range of 0 005% to 0.05% to 4% to 5% or %

C; 0.5% or less of Si, 0.20% to 1.80% of Mn, 0.03% or end contain at least one element of Nb and Ti; at least one less of P; 0.005% of less of s; 14.0% to 18.0% of Cr. element selected from the group consisting of Zr, B, and 5.0% to 8.0% of Ni; 1.5% to 3.5% of Mo; 0.5% to 3.5% of W; or Ca, singly or in combination. Preferably the steel of Cu, 0.05% of less of Al; 0.26% of less of V; 0.01% to 1 mor pipe has a martensitic structure containing 5 to 25 per-0.15% of N; and 0.006% or less of O on a mass basis, niete or cent by volume of a residual austenite phase; or further and satisfies the following expressions: Cr + 0.65Ni 4 containing 5% percent by volume of less of a femite 0.6Mo+0.55Cu-20C≥18.5 and Cr+ Mo+0.3Si-43.5C - 0.4Mn - Ni - 0.3Cu - 9N \$ 11 (Where Cr, Ni, Mo, Cu, C, other Si, Mn, and N represent their respective contents (mass%)). After such a steel pipe material is formed into the ments containing carbon dioxide gas (CO2), chloride a steel pipe, the steel pipe is que nched by cooling after or half long (Ci-), or the like is all to see of and in second heating to a temperature of the Acs transformation point of th then cooled to a temperature of Marcant or less, and temperature at the Act that a finite in the food black cooled to the Act transformers and temperature of the Act transformers and temperature of the Act transformers in which temperature is also become by Volume or in the oily phase are trived. Accordance of the Act transformers are trived.

A steet composition contains: 0.05% or less of 100 formation point or less. The composition may further phase. Thus, the resulting stainless steel pipe for oil Country lubular goods exhibits a superior corrosion re-On a sistance even in extremely severe, corrosive environto the method tho sulfide streins painting resistance is remarkeby enhanced by laming it methodic stratture constitute 20 percent by volume of viore of yiphase

[0007] agrigate of Linux amire to Taleof Ab shoation Publication Well (2007) and associous detectors of sale states are exoorhamii n. 10 - 10 15% of Ochaving e piconoreorrasion resistaron end suffice strass-comosio. Gacklin n This had noted as sames used has a composition in which the Or content is set at 10%, or 16%, use O content is the break as a same of to be sectional Diobard to 1965a, 4,0% or more of Ne and 0,7% to 3% of Ou are added in committed as to 1975 to 3,0°° of Male Fother sidded. Furthermore Nogli<mark>of the nombrabilan is set at 16</mark> or the all Tibushita Fother of Fother Fother curries a in contende signification for phase is madelished base. and in tendust and the circuit and in the conpercentable of the termination marketaile, when and the marketeristic phase is self-in the range of Affect Afric обиться переврагую и переврагий выполнения выполнения выполнения по переврагий выполнения выполнения выполнения

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Description

Technical Field

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[0001] The present invention relates to steel pipes for oil country tubular goods used in crude oil wells and natural gas wells. In particular, the present invention relates to an improvement of corrosion resistance to extremely severe, corrosive environment in which carbon dioxide gas (CO<sub>2</sub>), chloride ions (CI), and the like are present.

Background Art

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[0002] Deep oil wells, which have not conventionally been regarded at all, and corrosive sour gas wells, the development of which was abandoned for a time, have recently been developed increasingly on a world scale in order to cope with increase of crude oil price and anticipated oil resource depletion in the near future. These oil wells and gas wells generally lie at great depths in a several corrosive environment of a high-temperature atmosphere containing corrosive substances; such as CO<sub>2</sub> and CP-Accordingly, steel pipes for oil country tubular goods used for digging such an oil or gas well have to be highly strong and corrosion-resistant.

[0003] In general, highly CO2 corrosion-resistant 13%-Cr martensitic stainless steel pipes are used in oil wells and gas wells whose atmospheres contain CO2. Ch, or the like. However, conventional martensitic stainless steels cannot wear in environments at high temperatures of more than 100°C containing a large amount of Cl. Accordingly, two-phase stainless steel pipes are used in oil wells requiring corrosion resistance. Unfortunately, the two-phase stainless steel pipes contain large amount of alloying elements to reduce the hot workability? Consequently, they must be manufactured only by special hear treatment due to their reduced hot workability? and besides, they are disadvantageously expensive. Accordingly, an inexpensive 13%-Cr martensitic stainless steel based pipe for foil country tubular goods having a superior hot workability and Co2 corrosion resistance has been strongly desired. On the other hand, oil well development in cold districts has recently become active, and, accordingly, superior toughness at low temperatures is often required in addition to high strength; limited.

[0004] To these demands, improved martensitic stainless steels (or steel pipes) based on a 13%-Cr martensitic stainless steel (or steel pipe), having an enhanced corrosion resistance have been proposed in, for example, dapanesse Unexamined Patent Application Publication Nos. 8-120345, 9-268349, and 10-1755 and dapanesse Patent Nos. 2814528 and 3251648.

[0005] Japanese Unexamined Patent Application Publication No. 8-120345 has disclosed a method for manufacturing a seamless martensitic stainless steel pipe having a superior corrosion resistance? For acteel composition of a 13%-Cr martensitic stainless steel pipe, the C content is limited to the range of 0.005% to 0.05%, 2.4% to 6% of Ni and 0.2% to 4% of Cu are added in combination, and 0.5% to 3% of Mo is further added. Furthermore, Nieq is set at 10.5 or more. This steel material is subjected to hot working, subsequently cooled at air-cooling speed or more, and then tempered. Afternatively, after being cooled, the steel material is further heated to a temperature between Ac3 transformation point +1,0°C and Ac3 transformation point +200°C, or a temperature between Ac1 transformation point and Ac3 transformation point, subsequently cooled to room temperature at air-cooling speed or more, and then tempered. According to this method, a seamless martensitic stainless steel pipe is achieved which has a high strength of the grade AP1-C95 or grater, corrosion resistance in environments at 180°C or more containing CO2, and SCC resistance.

[0006] Japanese Unexamined Patent Application Publication No. 9-268349 has disclosed a method for manufacturing a martensitic stainless steel having a superior stress-corrosion cracking resistance to sulfides. In this method, a steel composition of a 13%-Cr martensitic stainless steel contains 0.005% to 0.05% of C, 0.005% to 0.1% of N, 3.0% to 6.0% of Ni, 0.5% to 3% of Cu, and 0.5% to 3% of Mo. After hot working and being left to cool down to room temperature, this steel material is heated to a temperature between (A<sub>C1</sub> point + 10°C) and (A<sub>C1</sub> point + 40°C) for 30 to 60 minutes, then cooled to a temperature of Ms point or less, and tempered at a temperature of A<sub>C1</sub> point or less. Thus, the resulting steel has a structure in which tempered martensite and 20 percent by volume or more of γ phase are mixed. According to this method, the sulfide stress-corrosion cracking resistance is remarkably enhanced by forming a martensitic structure containing 20 percent by volume or more of γ phase.

[0007] Japanese Unexamined Patent Application Publication No. 10-1755 has disclosed a martensitic stainless steel containing 10% to 15% of Cr, having a superior corrosion resistance and sulfide stress-corrosion cracking resistance. This martensitic stainless steel has a composition in which the Cr content is set at 10% to 15%; the C content is limited to the range of 0.005% to 0.05%; 4.0% or more of Ni and 0.5% to 3% of Cu are added in combination; and 1.0% to 3.0% of Mo is further added. Furthermore, Ni<sub>eq</sub> of the composition is set at -10 or more. The structure of the martensitic stainless steel contains a tempered martensitic phase, a martensitic phase, and a residual austenitic phase. The total percentage of the tempered martensitic phase and the martensitic phase is set in the range of 60% to 90%. According to this disclosure, corrosion resistance and sulfide stress-corrosion cracking resistance in environments where wet

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carbon dioxide gas or wet hydrogen sulfide is present are enhanced: 90.301 3301 to depend and entermolecus [0008]. Japanese Patent No. 2814528 relates to an oil well martensitic stainless steel product having a superior sulfide stress-corrosion dracking resistance. This steel product has a steel composition containing more than 15% and 19% or less of Cr. 0.05% or less of Cr. 0.1% or less of N, 3.5% to 8.0% of Ni; and 0.1% to 4.0% of Mo; and \$\text{simultaneously satisfying the relationships: 30Cr + 36Mo + 14Si - 28Ni ≤ 455 (%); and 21Cr + 25Mo + 17Si + 35Ni ≤ 731 (%). According to this disclosure, the resulting steel product exhibits a superior corrosion resistance in severe environments in oil wells where chloride ions, carbon dioxide gas, and, a small amount of hydrogen sulfide gas are present.

[0009] Japanese Patent No. 3251648 relates to a precipitation hardening martensitic stainless steel having superior strength and toughness. This martensitic stainless steel has a steel composition containing 10.0% to 17% of Cr, 0.08% or less of C, 0.015% or less of N, 6.0% to 10.0% of Ni, 0.5% to 2.0% of Cu, and 0.5% to 3.0% of Mo. The structure of the steel is formed by 35% or more cold working and annealing and it has a mean crystal grain size of 25 μm or less and precipitates with a particle size of 5 × 10<sup>-2</sup> μm or more in the matrix. The number of the precipitates is limited to 6 × 10<sup>6</sup> per square millimeter or less!/According to this disclosure; a high-strength precipitation hardening martensitic stainless/steel in which toughness degradation does not occur can be achieved by forming a structure containing fine crystal grains and less precipitation, has did to a cold of 150 or linearies and the strength procipitation. The did to a cold of 150 or linearies and the structure of borders. A (8) Disclosure of Invention announced border of 100 or the cold of the structure of Invention announced printenses.

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Unexamined Patent Application Publication Nos. 18-120345;-9-268349; and 310-1755 and Japanese Patent Nos. 2814528 and 3251648 do not stably exhibit desired corrosion resistance in Severe; corrosive environments at temperatures of more than 180°C containing CO<sub>2</sub>; Chror the like, and instances a printipal unergode bothem A (11) [0011] In view of the circumstances of the known arts stated above; the present invention has been achieved. The object of the present invention is to provide an inexpensive, corrosion resistant stainless steel pipe for foil country

tubular goods, preferably a high-strength stainless steel pipe for oil country/tubular goods; having a superior hot workability/and exhibiting a superior CO<sub>2</sub> corrosion resistance even in severe; corrosion environments at temperatures of mole than 180°C containing CO<sub>2</sub>, Cop or the tike, and not be an end and analysis of the present invention is as follows: o environment at a end sets and paragraph and than a number of containing CO<sub>2</sub> and to environment a set of containing code and the code of code of the code of t

2 ° (1) A corrosion-resistant stainless steel pipe for oil country tubular goods having a steel composition comprising, on a mass basis, 0.05% or less of G; 0.50% or less of Si; 0.20% to 1.80% of Mn; 0.03 or less of P; 0.005% or less of S; 14.0% to 18.0% of Cr; 5.0% to 8.0% of Ni; 1.5% to 3.5% of Mo; 0.5% to 3.5% of Cu; 0.05% or less of Ai; 0.20% or less of V; 0.01% to 0.15% of N; 0.006% or less of O and the balance being Fe and incidental impurities. The composition satisfies expressions (1) and (2):

aland %arem a no a Critt No. t 0.381 - 43.5C - 0.4Mn - Ni -0.3Cu -9N ≤ 11 .0 ≤ .01 .10 cred w. (2)

433) A method for manufacturing a seamlers strong as some upon oil country ubusin goods according to 120 m

(2) A corrosion-resistant stainless steel pipe for oil country tubular goods according to (1) in which the composition (6) further contains at least one element of 0:20% or less of Nb and 0.30% or less of Ti on a mass basis (4.4)

(3) A corrosion-resistant stainless steel pipe for oil country tubular goods according to (1) or (2) in which the com-20 position further contains at least one element selected from the group consisting of 0:20% or less of Zr, 0.01% or 26 less of B; and 3:0% or less of W on a mass basis we sectored a sectored a generosian and the bodient A (31)

the composition further contains 0.0005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% of Caron a mass basis! 10 3°10 C 12 to 220150 3°00.005% to 0.01% to 0.01%

(1) A stainless steel pipe for oil country tubular goods according to any one of (1) to (4) and whose structure includes to 25 percent by volume of a residual austenitic phase and the balance being a martensitic phase.

(6) A corrosion-resistant stainless steel pipe for oil country tubular goods according to any one of (1) to (4) and whose structure includes 5 to 25 percent by volume of a residual austenitic phase; 5 percent by volume or less of a ferrite phase, and the balance being a martensitic phase.

500 (7) A method for manufacturing a corrosion-resistant stainless steel pipe for oil country tubular goods including the steel pipe form a steel pipe material having a composition; quenching the steel pipe by heating the steel pipe to a temperature of the A<sub>C3</sub> transformation point thereof or more and subsequently cooling to room temperature at air-cooling speed or more; and then tempering the steel pipe at a temperature of the A<sub>C3</sub>.

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transformation point thereof or less. The composition contains, on a mass basis, 0.05% or less of C; 0.50% or less

of Si; 0.20% to d.80% of Mn; 0.03; or less of P; 0.005% or less of S; d.4:0% to 18.0% of Cr; 5.0% to 8.0% of Ni: 1.5% to 3.5% of Mo; 0.5% to 3.5% of Cu; 0.05% or less of Al; 0.20% or less of V; 0.01% to 0.15% of N; 0.006% rest or less of O, and the balance being Fe and incidental impurities, and the composition satisfies expressions (1) and udu(2):::A un regretidad de maior divisis processas un regretidad de madas en Octobración de está discomenta nje u trook, provinci rena mervas u astrousion (150). 💎 👙 1998 - siltanksalloubony laurogo Busta (2006) dia savrano sida o politics) — electromy objects and catalogues of the companies of the catalogues of the control of the catalogues are catalogues. The end of the catalogues are catalogues and of the catalogues are catalogues and catalogues are catalogues. and dishipitates (with a part on size of £ 100% units of the size of the number of the practicular as the restor afte operative GreNipMoACueC, SigMnpand.N represent their respective contents வங்களிய வக்க வரை இர and (8) Armethod for manufacturing a stainless steel pipe for oil country, tubular, goods, according to (7) in which the composition further contains at least one element of 0.20% or less of Nb and 0.30% or less of Ti on a mass basis. (9) A method for manufacturing a stainless steel pipe for oil country tubular goods according to (8) in which the quenching includes heating to a temperature in the range of 800 to 1100°C and cooling to room temperature at air-cooling speed or more, and the tempering is performed at a temperature in the range of 500 to 630°C. 220 (10) A method for manufacturing a stainless steel pipe for oil country tubular goods according to any one of (7) to :01 (9) in which the composition further contains at least one element selected from the group consisting of 0.20% or 2814628 and 32/1646 do not stably exhibitalizad asan who less of Worlds and 32/1646 do not stably exhibitalized asan was not stably or less of Worlds and 32/1646 do not stably exhibitation of worlds and 32/1646 do not stable exhibitation of world exhibitation of worlds and 32/1646 do not stable exhibitation of world exhibitation (11) A method for manufacturing a stainless steel pipe for oil country tubular goods according to any one of (7) to ger 1(10), in which the composition further contains 0.0005% to;0:01% of Caron armas; basis; additionary of 12:001 পাল (12) A method for manufacturing a corrosion-resistant seamless stainless steel pipe for oil country tubular goods, are including the steps of: forming a steel pipe from a steel pipe material having a composition by hot working; cooling coult the steel pipe to room temperature at air-cooling speed or more, or quenching the steel pipe by further heating to a temperature of the A<sub>CS</sub> transformation point thereof or more and cooling to coom temperature at airscooking speed or more; and then tempering the steel pipe at a temperature of the Act transformation point thereof or less The composition contains, on a mass basis, 0.05% or less of C; 0.50% or less of Si; 0.20% to 1.80% of Mn; 0.03 Deportess of P; 0:005% ordess of:Sp14:0% to 18.0% of Cr; 5.0% to 8:0% of Ni; 1:5% to 3.5% of Mo; 0.5% to 3:5% of eagl Cu; 0:05% or less of Al; 0:20% or dess of V; 0.01% to 0.15% of N; 0.006% or less of O; and the balance being Fe A :and/incidental impurities? and the composition satisfies expressions (1) and (2): 10 to 30 8 rot 30 0.20% or loss of  $\hat{V}$  10ths to 0.15% of N10 006% or out of the balance being the appropriate impurities

which the composition further contains at least one element of 0.20% or less of Nb and 0.30% or less of Ti on a natural state of the propherous above the element of 0.20% or less of Nb and 0.30% or less of Ti on a natural state of the propherous above the element of the eleme

(13) A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to (12) in

,where Cr, Ni, Mo, Cu, C, Si, Mn, and N represent their respective contents on a mass% basis.

STREE (16): As method for manufacturing a seamless stainless steel pipe for oil country tubulategoods according to any one of (12) to (15); in which the composition further contains 0.0005% to 0.01% of Calonia mass basis: ulbridge (15) to 900 years of ordered shows the contains 0.0005% to 0.01% of Calonia mass basis: ulbridge (15) to 900 years of ordered shows the contains 0.0005% to 0.01% of Calonia mass basis: ulbridge (16) to 900 years of ordered shows the contains 0.0005% to 0.01% of Calonia mass basis: ulbridge (16) to 900 years of ordered shows the contains 0.0005% to 0.01% of Calonia mass basis: ulbridge (16) to 900 years of ordered shows the contains 0.0005% to 0.01% of Calonia mass basis: ulbridge (16) to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of ordered shows the contains 0.0005% to 900 years of 0.0005%

to: According to the organical states of the control of the contro

[0013]::::"High strength" in the present invention refers to a strength (yield strength: 550 MPa or more) that conventional 13%-Or martensitic stainless steel pipes; for oil country-tubular goods, have, and preferably, to:a yield strength of 654 MPa or more: geadualone enoming tended into a restriction of a nutries of the present invention have conducted [0014]; this orders to accomplish; the above-described objects, the inventors of the present invention have conducted

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intensive research on the effects of alloying element contents to corrosion resistance in corrosive environments at high temperatures in the range of more than 180°C to 230°C containing CO32CI, or the like, based on the compositions of the improved 13%-Cr martensitic stainless steel pipes of the distribution and the improved the saw of the improved [0015] As a result, it has been found that both of a favorable not workability and a superior corrosion resistance in sévere, corrosive environments can be ensured by reducing the C content to be lower than that of the known/13%-Cr mariensilic stainless steets and adding suitable amounts of Ni; Mo, and Cu to adjust alloying element contents; so as to satisfy following expressions (1) and (2): Cur r. 5% to 3.5%. [00:20]. The element Octistiong thans the procedure fact or the created of the steel to prevent from the decide tration into the steel, thereby enhancing the subtide stress competitive cracking resistance. This office is abhevious when (f) Occontent is 0.5% or more. However, a content of more than 3 and to reduce the hot workshifty. Accordingly, the Culconto C.1. Ilmitim to the range of 0.5% to 0.5%, Charlingly, It is accordingly. in the range of 0.5% to 2.5%. Cr + Mo + 0.3Si - 43.5C - 0.4Mn - Ni - 0.3Cu - 9N ≤ 11 Al: 0.05% or less [0027] The element Al had a strong effect of decidency, but a content of more than 0.65% negatively at many that The Swherein Cr. Ni; Mo, Cu, CoSi; Mn3 and N represent their respective contents (mass%). Furthermore pit has been -290 0 dt found that a high strength of 654 MPa or more in terms of yield strength can be ensured. V: 0.20% or less [0016] The present invention has been completed based on these findings. [0017] The reason why the steel compositions are controlled will now be explained. Hereinafter, mass percent is ing resistance. These effects are noticeably oxinibited when the Vironient is 0.03% or more, rigidmic yd besserge more than 0.20% reduces the bughness. Accordingly the Victimer is dimited to 0.20% or lesseeings-200,0.3 set in [0018] C is an essential element relating to the strength of martensitic stainless steel, butta(C:content of more than 0.05% promotes sensitization at the stage of tempering due to the presence of Ni. In order to prevent the sensitization at the stage of tempering the Cocontent is limited to 0.05% or less in the present invention! In view of corrosion resistance; it is preferable that the C content be set as lower as possible. Preferably; it is 0:03% or less : More preferably; ness Accordingly, the Nicontoni is limited to the range of himfold 3.55% P. 28000 of \$1000 for signar adminites at the Si: 0.50% or less to 0.15%, and more preferably in the range of 0.65% to 9.68%. [0019] The element Si serves as a deoxidizer, and, preferably, its content is 0.05% or more in the present invention. However, a content of more than 0.50% reduces the CO<sub>2</sub> corrosion resistance and further reduces the hot workábility -Accordingly, the Si content is limited to 0.50% or less. Preferably it is set in the range of 0.10% to 0.30% t eldణ ভাৰত not workability. CO<sub>2</sub> stress-con usion oracking resistance. Citing oct cased resistance, sulfid **%08**; http://www.new.nd.cking. [0020] The element Mn enhances steel strength. In order to ensure a strength desired in the present invention; the Mn content has to be 0:20% or more. However, a content of more than 1:80% negatively affects the toughness & Act cordingly, the Mn content is limited to the range of 0.20% to 1.80%. Preferably, it is set in the range of 0.20% to 1.00%! [0632] Both the elements Altrand Transmost the strong is 808.0 of %02.030 against the rand in the grand of the present that the strong is the strong is the strong in the strong in the strong is the strong in the remarkably by tempering at a relatively low temperature in the cares of 500 to \$30°C. This effecteel activities (19) through [0021] The element P negatively affects the CO2 corrosion resistance, CO2 stress-corrosion cracking resistance, pitting corrosion resistance, and sulfide stress-corrosion cracking resistance; and it is preferable that the Pontent be reduced as low as possible. However, an excessive reduction of P content increases cost. Accordingly, the P content is limited to 0.03% or less so as to allow industrial production at a low cost and prevent the degradation of CO2 corrosion resistance CO estress-corrosion cracking resistance, pitting corrosion resistance and sulfide stress-corrosion (resist) ance. Preferably, it is set at 0.00% or: less, a bine. If to less no 1210 0 no bis set no 200,0 to gritate noon quotig entil month [DD34] Zt. B. and Weach increases the strength and at least one of them may be added if izaelino %200,042/ibit i [0022] The element S seriously reduces hot workability in manufacture of pipes, and the S content is; preferably, as low as possible. A S content of 0.005% or less makes it possible to manufacture pipes through a common process, and) therefore the S content is limited to 0.005% or less Preferably attricted at 0.003% of less and across the content is limited to 0.005% or less and 0.005% or of W. the toughness is raduced. Accordingly, the 2r content is profit ably limited to 0.20% or %0.8h of %0.8h:rD0 0.1% [0023] The element Cr forms a protective film on the surface of steel to increase the corrosion resistance and particularly to increase the CO2 corrosion resistance and CO2 stress-corrosion cracking resistance on the present invent tion, a Cricontent of 14.0% or more is necessary from the viewpoint of increasing the corresion resistance at high temperatures. However, a content of more than 18:0% reduces the hot workability. Accordingly, the Cr content is limited to the range of 14.0% to 18.0% in the present invention. Preferably, it is set in the range of 14.5% to 17.5% as 2003 them 0.01% increases CaO, and reduces the CO<sub>2</sub> corresponding and pitting resistant**%0.8:of %0.7:iiN**ne Ca [0024] The element Ni strengthens the protective film on the surface of steel to enhance the CO2 corrosion resistance and CO2 stress-corrosion cracking resistance; pitting corrosion resistance; and sulfide stress-corrosion cracking resistance. Furthermore, it has the effect of a solid solution strengthening and, accordingly, increases steel strength. These effects are exhibited when the Ni content is 5.0% or more. However, a content of more than 8.0% reduces the stability of the martensitic structure to decrease the strength. Accordingly, the Ni content is limited to the range of 5.0%

to 8.0%. Preferably, it is set in the range of 5.5% to 7.0%.

EP 1 514 950 A1 A SECOND CONTROL OF THE PROPERTY OF THE PROPERTY OF THE PARTY OF THE P read, Mot: 1.5% to 3:5% paragraph of the received of [0025] :: The element Mo enhances the resistance to pitting by Cl , and a content of 1.5% or more is necessary in the present invention. While a content of less than 1.5% does not efficiently achieve the corrosion resistance in severe, corrosive environments: at high temperatures; a content of more than 3.5% causes the formation of  $\delta$ -ferrite to reduce the hot workability, CO2 corrosion resistance, and CO2 stress-corrosion cracking resistance and increases cost. Accordingly; the Mo; content is limited to the range of 1.5% to 3.5%. Preferably; it is set in the range of 1.5% to 2.5%. Cu: 0.5% to 3.5% to satistic tollowing errors agens (1) and (2) [0026] The element Cu strengthens the protective film on the surface of the steel to prevent from hydrogen-penetration into the steel, thereby enhancing the sulfide stress-corresion cracking resistance. This effect is achieved when the Cu content is 0.5% or more. However, a content of more than 3.5% allows CuS to precipitate in grain boundaries to reduce the hot workability. Accordingly, the Cu content is limited to the range of 0.5% to 3.5%. Preferably, it is set in the range of 0.5% to 2.5%. 1279 JOSC 1 ALC: 08:04 BEC+6M+1. Al: 0.05% or less [0027] The element Al has a strong effect of deoxidation, but a content of more than 0.05% negatively affects the toughness of the steel. Accordingly, the Al content is limited to 0.05% or lesse Preferably, it is set in the range of 0.01% found to else about the area with a 854 MPP or more to the state of the combine absume. to 0.03%. V: 0.20% or less The present invention has been completed to the condition [0028] 16: The element V. enhances the strength of steel and also has the effect of improving the stress-corrosion cracking resistance. These effects are noticeably exhibited when the V content is 0.03% or more...However, a content of more than 0.20% reduces the toughness. Accordingly, the V content is limited to 0.20% or less: Preferably, it is set in theirange of 0:03%:to10:08%, lead is a shall be to strength or to strength or to strength with the calculation of the strength 0.05% en amotos sensitization at the stage of tempering ducit. The orienence of Nt. In order to %3.0.05tb%10.05tN attion [0029] oo The element N extremely enhances the pitting corrosion resistance. This effect is exhibited when the N content is 0:01% or more. However, a content of more than 0.15% allows the formation of various nitrides to reduce the toughness. Accordingly, the N content is limited to the range of 0.01% to 0.15%. Preferably, it is set in the range of 0.03% to 0.15%, and more preferably in the range of 0.03% to 0.08%. St: 0.50% or less rotth Otro.006% ot less in writing 1/20 to at the tricing in a single [0019] The element Si serves as a pecitional and profin [0030] noThe element O is present in oxide forms in steel and negatively affects various characteristics. It is, therefore, preferable to be reduced as low as possible. In particular, an O content of more than 0.006% seriously reduces the hot workability, CO2 stress-corrosion cracking resistance, pitting corrosion resistance, sulfide stress-corrosion cracking resistance; and toughness: Accordingly, the Ocontent is limited to 0.006% or lesson time to the mail and the order of the [0031], entry the present invention in the above-described basic composition may further contain at least either 0:20% or doublegive the title content is lemited to the range of 0.20% to 6.6% of enable it is self-foraseling-900.0, no-dN forasel [0032] Both the elements Nb and Ti enhance the strength and the toughness, and particularly increase the strength remarkably by tempering at a relatively low temperature in the range of 500 to 630°C. This effect is noticeably exhibited when the Nb and Ti contents are 0.02% or more and 0.01% or more respectively. On the other hand, a Nb content of more than 0:20% and a Ticontent of more than 0.30% reduce the toughness an addition Tichas the effect of improving the stress-corrosion cracking resistance Accordingly, the Nb content is preferably limited to 0.20% or less, and the Ti is limited to 0.03% or less so as to ellow industrial production of the first and provent the degralazelinoxi00.0xtnethox [0033] notin the present invention; the above-described composition may further contain at least one element selected from the group consisting of 0.20% or less of Zr, 0.01% or less of B, and 3.0% or less of W. tos at a yidesched some [0034] Zr, B, and W each increases the strength, and at least one of them may be added if necessary. In addition to the effect of increasing the strength, Zr, B, and W can improve the stress-corrosion cracking resistance. These effects are noticeably exhibited when the composition contains 0.01% or more of Zr, 0.0005% or more of B, or 0.1% or more of W. On the other hand; if the composition contains more than 0.20% of Zr, more than 0.01% of B, or more than 3.0% of W, the toughness is reduced. Accordingly, the Zr content is preferably limited to 0.20% or less; the B content; 0.01% or less and the increase of the surfactive film on the surface of [0035] and in the present invention of the composition may further contain 0.0005% to 0.01% of Cat passaged on wheleour [0036] at the element Ca forms CaS to fix the element S and, thus, to spheroidize sulfide inclusions, thereby reducing lattice distortion of the matrix in the vicinity of the inclusions to reduce the capability of trapping hydrogen of the inclusions sions advantageously. This effect is achieved when the Ca content is 0:0005% or more. However, a content of more than 0.01% increases CaO, and reduces the CO2 corrosion resistance and pitting resistance Accordingly, the Ca

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[0024] The element Wistengther and element in strengther are serviced with the strength of which in the strength of the above and serviced with the strength of the strength o

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то ехот, ак две в 1 стото рабо при начини и интерестори (10 м), и пред 8 д по втителение полителение А. 1070ft/ в в внего таки по тото по тото по доступном началением (20, 43,50, - 0,4Mn - Ni - 0,3Cu - 9N ≤ 11 для эй эк то по по това из казав (2) assistant 2000 a committee assistant assistant light in the or, tradmich a office in the company of a figure wherein Or, Ni, Mo, Ou, C; Si, Mn}and N represent their respective contents screenes including to honorise [0038] By adjusting the Cr, Ni, Mo, Cu, and C contents so as to satisfy expression (1), the corrosion resistance in environments at high temperatures up to 230°C including CO2 or CI is remarkably increased. Also, by adjusting the Cr. Mo. Si, C, Mn, Ni, Cu, and N contents so as to satisfy expression (2), the hot workability is enhanced. In the present invention, P, S, and O contents are significantly reduced in order to enhance the hot workability. However, reducing the P. S. and O contents is not enough to ensure a hot workability sufficient to produce seamless martensitic stainless steel pipes. In order to ensure a hot workability sufficient to make seamless martensitic stainless steel pipes; it is important to extremely reduce the P, S, and O contents, and besides to adjust the Cr. Mo, Si, C, Mn, Ni, Cu, and N ີວິວິກtents so as to satisfy expression (2). ທັກສາ ເຂົ້າ ທີ່ສາດ ການ ສຸກຄາດ ຄອກ ຄອກ ຄວາມເຮັດການຄວາມຄວາມ [5800] া[0039] স্পThe balance of the foregoing elements is Fe and incidental impurities চৈবচহাত্ত এছে চল্লা হৰলৈ (৪.৫৪৮) হয় [0040] Preferably, the steel pipe of the present invention has a structure comprising 5% to 25% of residual austenite rphase on a volume basis and the balance being a martensite phase. Alternatively, the steel pipe of the present invention has a structure comprising 5% to 25% of residual austenite phase; 5% or less of ferrite phase, and the balance being [0054] The seamless steel bloe was cut into a lost precent to the precent waitand amulovia not be also and a market and a [0041] Although the structure of the steel pipe of the present invention is essentially composed of the martensite >phase, the martensite phase, preferably, contains 5% to 25% of a residual austenite phase, or further contains 5% or plessiofra ferriterphase; on a volumerbasish entities as in the common and a manufacture of a factorist and a demonstration and the permitted and the permit [0042] a By allowing 5 percent by volume of more of residual austenite phase to be present; a high-toughness can be achieved. However, more than 25 percent by volume of residual austenite phase reduces the strength: Accordingly strength and a strength of the ાંs preferable that the percentaĝe of the residual austenite phase is set in the range of 5રાઇ 25 percent by volume પીંગ additions in order to enhance the corrosion resistance, it is preferable that 5 percent by volume or less of ferrite phase is allowed to be present. However, more than 5 percent by volume of ferrite phase remarkably reduces the hot workeability. Accordingly, it is preferable that the percentage of the ferrite phase is set at 5 percent by volume of less 2001 [0043]∍<A method for manufacturing the steel pipe of the present invention will now be described taking at seamless steel pipe as an example rodsoffinger a to equithe test was observed to check for the occurrence of piliting and [0044] First, it is preferable that a molten steel having the above-described composition be melted by a conventional steel making process using a converter, an electric furnace, a vacuum melting furnace, or the like, and then formed into a steel pipe material, such as, a billet by a conventional method, such as continuous casting or ingot makingslabbing. Then, the steel pipe material is heated and subjected to hot working to make a pipe by a common manufacturing process, such as that of Mannesmann-plug mill or Mannesmann-mandrel mill. Thus a seamless steel pipe with a desired size is yielded. After pipe making, the resulting seamless steel pipe is preferably cooled to room temperature at air-cooling speed or more.

[0045] The seamless steel pipe having the above-described steel composition can be given a structure mainly composed of a martensite phase by cooling at air-cooling speed or more after hot working. After the cooling at air-cooling speed or more, preferably, quenching is performed in which the steel pipe is heated again to a temperature of the  $A_{C3}$  transformation point or more and cooled to room temperature at air-cooling speed or more. Thus, the martensitic structure can be refined and the toughness of the steel can be increased.

[0046] Preferably, the quenched seamless steel pipe is subjected to tempering by being heated to a temperature of the A<sub>C1</sub> transformation point or less. By heating to a temperature of the A<sub>C1</sub> transformation point or less, preferably to 400°C or more, for tempering, the resultant structure comprises a tempered martensite phase, further comprises a residual austenite phase, or still further comprises a small amount of ferrite phase in some cases. Thus, the resulting seamless steel pipe exhibits a desired strength, a desired toughness, and a desired, superior corrosion resistance.

[0047] Only tempering may be performed without quenching.

[0048] The description above illustrates a steel pipe of the present invention taking the seamless steel pipe as an example, but the present invention is not limited to this form. A steel pipe material having the composition within the scope of the present invention may result in an electric welded steel pipe or a UOE steel pipe used as a steel pipe for oil country tubular goods through a conventional process. However, for the electric welded steel tube and UOE steel pipe, it is preferable that, after pipe making, the pipe is quenched by heating the pipe again to a temperature of the  $A_{C3}$  transformation point or more and cooling to room temperature at air-cooling speed or more, and is subsequently tempered at a temperature of the  $A_{C1}$  transformation point or less.

[0049] In the case of a steel pipe having a composition containing at least one element of Nb and Ti, quenching includes heating to a temperature of 800 to 1100°C, and cooling to room temperature at air-cooling speed or more. Also, tempering is preferably performed at a temperature in the range of 500 to 630°C. By subjecting the steel pipe having the composition containing at least one element of Nb and Ti to these quenching and tempering, a sufficient amount of fine precipitates can occur to achieve a high strength of 654 MPa or more in terms of yield strength.

[0050] A quenching temperature of less than 800°C does not sufficiently achieve the effect of tempering to provide a desired strength. On the other hand, a quenching temperature of more than 1100°C coarsens the crystal grains to reduce the toughness of the steel. While a tempering temperature of less than 500°C does not pricipitate a sufficient amount of precipitations, a tempering temperature of more than 630°C remarkably reduces the strength of the steel. ndust liky adunam blood till mit. Do, wid 5 cangen sick in lighters with the normanin lesignment ्रम् ५%केन्द्र ३,१७५ त. qu इत्यामः एद १०५% त्या 🖫 प्राप्तकायकारमञ् (Examples): A. Trank boasecone (idinatural acningaging and the programmer at while become control of the contro [0051]: The present invention will be further described in detail with reference to Examples. It bas is 4 increased incipe Signed Orionizates no located to ensure a hot word. If will find of diadrace seamilies markenatin stainless sized pages in order to ensure a not workability subject to model, meaning the includes size (Example 1). important to extremely reduce the Nichold Converts lend to a little wifet the Children Mc Children No. Ou and N [0052] After degassing, each molten steel having a composition shown in Table 1 was cast into a steel ingot of 100 kgf (980 N). The ingot was subjected to hot working to make a pipe with a model seamless rolling mill, followed by air cooling.to.yield:a seamless steel pipe; with an outer diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 3:3 incby a thickness of 0.5 inthe diameter of 0.5 inthe diam [0053]: The hot workability was evaluated by visually observing the presence of cracks in the internal and external surfaces of the resulting seamless steel pipe as air-cooled after pipe making: @35 or @6 on accompagation has a ser [0054] The seamless steel pipe was cut into a test piece. The test piece was heated at 920°C for 1 hour and then water-cooled. The test piece was further subjected to tempering at 600°C for 30 minutes; it was ensured that quenching was?performed:on:each sample:at:a:temperature of its:Aca:transformation/point:or:;more;:and:that.tempering:was performed at a temperature of its A<sub>C1</sub> transformation point or less. The quench-tempered test piece was machined into (a) corrosion-test piece, of 3 mm; in thickness by 30 mm in width, by (40 mm; in length; followed by a corrosion test, Some of the steel pipe samples were subjected to only tempering without quenching os #1 promitted to only tempering without quenching of #1 promitted to only tempering without quenching without [0055] In the corrosion test, the test piece was immersed in a test solution being 20% NaCl aqueous solution placed in an autoclave (solution temperature: 230°C, CO<sub>2</sub> gas atmosphere at a pressure of 100 atmospheres) and was allowed is allowed to be present. However, then 5 percent to the more to keep for 2 weeks. I vidaxisine reasing sento [0056]20 The test piece after the corrosion test was weighed, and the corrosion rate was obtained from the difference between the weight of the test piece before the test and that after the test. The surface of the corrosion test piece after the test was observed to check for the occurrence of pitting with a loupe of a magnification of 10 times are equal to all state: making process using a convenier an avector to had the - the fing rumace of the discard then formed into a stept cape material coupries is bifor by a convenions. It is such as confinence casting or angot making stabbing. There tha steet place materialists haated ago subscience of continuity to make a pige-lovik common manuface luding princese, such as that of Mannessammers to much of Monte, in the expedicit ZNII. Thus in secretars stoerpression and streaming meror of the brach takes end at state . and grath, as any present and other probably to we begin the ar att-bookhu speed or niora (2045) The seconlesh steel his chaving the above-culton of the mini viniem erebetas a nevej ed han notides min diet not werking. After the cooling at att-cooling posed of a martensite phase by policing at an ecoting structure of sphad or more profescity quanching is performed in which the m pale is heeted again to a tempo nature of the Acr r coding abeed or there. Thus, the martenaing transfermation or into a and cooled to room tot give. structure can be infined and the toughness of the steel demoken 0 .... [0066] වන්න්ඩොද the guerched ser වනයේ වන්නේ වන 😁 ාය අනතුන්සුවල being bested to a temperature of the Autoration mander point or less. By heating to a temperation Thin A. Ennsionnation point or less preferable to approximation in the spring the lead and structure or more than Compared in idansile phase Tupher composes a medical equiencia privadi or acili furficial con privada e 🧸 met 🕟 💛 😅 derigi pinaesa lo somà casas. Thus libro cabillino seamists steel nige exhibits a deciral steening in a contract to a contr and a desired, superior corresion registance 1094∄ — (Intelligence nevice performed with high aconum investion talking the sentitless steet and addition 100/21 The Josephon chove Hindurates cipiled probabilities are and control having the composition within the example, but the present invention is not smitted to this town. 🔭 nocicris UOE steel pipe usad as a steel pipe for scope of the present invertion may result in an electric violities and ell council tubulat grads through a born shkonal process. May sate 300 bos oder took deblew stiff he entite pode it is byddarable thair athdr big'e makkno, the opperudicular a abarno tho pige adal y tigla (engonatore 41 tho art it oling coised or more, and is subsecutivity Act transportedien point of there and cobing to more turners in temporatiles a temperature of the  $A_{\rm C}$  inanciormation brinking in the companies [1043] In five case of a steel pipe having a composition, which is at least one element of No and Till quenching incredes herring this is hoperature of ACC to 1100°C, and respective or temperature at art-cooking speed or more A comparation of the minimum statement of a comparation of the of 500 to 630° G. By subjecting the stee, placinhad gucqotirg and tekinerna a suffici The commission that the grant artisphentians and configuration Consider the companies of visit of the consideration of the consideratio on the circulation is well to be included in this election calls in a circulation of the circulation of the circ

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Table	Н	ļ				1	-	!		<u> </u>		ļ					Exercise
Steel						Chemi	cal com	Chemical compositions (mass%)	s (mass	(%					Expression	Expression	1
S.	O	Si	Mn	Ь	Š	¥	ပ	Ξ	Mo	ರ	>	z	0	Other	(1).		C-4-STAFE
4	0.019	0.19	0.48	0.02	0.001	0.01	14.8	√5,19	1.60٪	0.65 0	0.049 0	0,059	0.0019		. ₹∆619.11	Si 9:5225	_oExample
œ	0.024	0.20	0.44	0.02	0.001	0.01	14.9	5.50	1.50	0.59	0.051 0	0.062	0.0025	Nb: 0.026	19.22	9.005	Example
ن	0.015	-0.24-	0.46	0.03	0.001	0.02	15.3	6.12	2.04	1.05	0.0590	0.043	0.0037	Zr.0.017	1350.78	9.7535	Example
a	0.025	0.22	0.50	0.01	0.002	<b>5</b> 000	15.1	5.59	2.49	ൂ.63	0.048 0	0,072	0.0021	Ti 0.034	20.62	9.6415	Example
Ш	0.027	0.20	0.42	0.01	0.001	0.02	15.5	6.27	1.75	0.777	0.040	0 033	0.0018		20.51	9.1695	Example
ш	0.024	0.21	0.40	0.02	0.001	0.01	16.2	5.93	1.66 01.14		0.041	0 039	0:0019	Ti: 0.021, B: 0.001	14021.20	G40:096	;ο:Example∂
U	0.020	2.28	0.41	0.01	0.001	0.01	16.5	6.05	2.17	0.88	0.030	0.054	0.0026	Ca: 0.002	21.82	10.914	Example
I	0.016	0.33	0.40	0.01	0.001	0.02	16.9	5.99	1.52	1.02 0	0.052 0	0.095	0.0038	Nb: 0.019, Ca: 0.001	21.95	10.512	Example
	0.026	0.28	0.48	╄	0.001	0.01	17.3	6.54	1.69	0.64	0.049 0	0,056	0.0030	W: 0.270	22.40	10.425	Example
5	0.017	0.27	0.49	0.01	0.001	0.00	17.7	7.05	1.53	0.85	0.042 0	690.0	0.0016	B. 0.001	23.33	10:4495	:
¥	0.034	0.27	0.50	7,0.02	0.001	.005 0.02	17.4	5.58	2.87	0.67	0.046	0 056	0.0028	<del> </del>	22.44	12,38Z	. Comparative ⊏Example
1	0.022	0.26	0.45	70.02	0.001	0.00	13.8	6.19	1.68 C	0.77	0.055 0	0,106	7,000,0		18.78	7.064	<ul> <li>Comparative</li> <li>Example</li> </ul>
Σ	0.045	0.31	0.49	C.01	0.002	0.01	14.6	5.11	1.55	0.59	0.048 0	0.042	0.0024	Ti 0.024	18.28	C-0000	Comparative = Example
z	0.020	0.26	0.42	0.03	0.002	20°0	14.7	4.55	1.53	0.69	0.063	0,059	0.0026		18.56 GoS 18.56	1300.082	— Comparativ ⊢Example
0	0.016	0.33	0.44	10.01	0.001	<b>10</b> 00	14.8	,5.27	0.58(00	00.73	0.065 0	0,058	0.0034	-	( DA:18.64	6.08.576	
D	0.021 <sub>9</sub>	0.21	0.44	70.05	0.001	0.02	17.1	5.15	1.98 <sub>€</sub>	0.57 C	0.058	0 062	0.0028	Nb: 0.033	-	32,1545	Comparative
σ	0.026 <sub>V</sub>	0.35	0.39	70.02	0.001	20.02	14.6	5.19	1.64€ 3 <u>0.26</u>	<u> </u>	0.045 0	0,038	0,00019	1	11319.10	(3009.45	Comparative- ⊢-Example
xpre	*) Expression (1) = (Cr) + 0.65 (NI) + 0.6 (Mo) **) Expression (2) = (Cr) + (Mo) + 0.3 (SI) - 43	= (C <sub>1</sub> ) +	0.65 (NI	) + 0.6 (I		+ 0.55 (Cu) - 20 (C) 5 (C) - 0.4 (Mn) - (N)	-20 (C)	+ 0.55 (Cu) - 20 (C) (LC) (LC) 5 (C) - 0.3 (Cu) - 9 (N)	()] ()]	<del> </del>	ppileod		(CI & COK	70°	elst noischpü - (nykmin)	Prilli9	<b>!</b>
of of the party	1997	ر -	s gniloo	errit selle grilloon		ieuO	Quenching	<u> </u>	5	First Fig. 1.5	-		Subdevices of	<u> </u>	0.52 o 82 o 65 o 60 o	(d)	
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5		Remarks		Example	Examples	Examples	Example	Examples	Examples	Example:	Example	i Example	Example	Comparative Example	S Comparative Example		Comparative Example	Comparative	ou Comparative Example	Comparative Example	Example
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15		Corrosion resistance	Corrosion rate (mm/yr)	0.113, 10	0.033 0.1023, 83	0.091	0,092,117pp	0.054 0.091	0.063 g v.	0.061	0.045	0.036	0.044		0.051 0.149,1:30	0.034 0.162 30.es	0.132 0.132 0 35	0.179ia <sub>1.1</sub>	ngisson 820.0	0.119	0.107
20		Hot workability	Crack	ерооб вел	08X G000g   10	328   <b>G</b> 0094	See Good	043 Good	Good .	↓ Poob ↓	Good	Good	Good	Good 17	036 Goode H		382 G0001 31	523 Badia	Good	Good	Good
25		ing	Cooling	a Alt i a	a Alt low	n All Colo	0.085	O.Als   clo	o Alf.	Air	Air	Air	Air	Air	0	- CAIS   O	Air of	O'AIR US	Air	Air	Air
<b>30</b>	Table 2	Tempering	1.7 Temp(4) (°C)	95.0 <sub>0</sub> 098.1	75 000g€ r	0.56000 13	000ga /	86000 38 I	1.000go.1	009	009	009	009	9009	51 1009∂;	-1-2	-600, VE	1 6 8003' 82	009	009	909
35		ching	"Cooling" so (c)	es Air is-	Y Alt	#P AIF SI	Alfra	H. SIV 6.	5.3 All 13	Air —	Air	Air	Air	Air Se le to	S Air o3	-   ⋖	Alr 2	s Air io	Alr	Air	-
40 .		Quenching	2 (*eć)**) -	920,	920	920	920	5   920	920	920	920	1.920	920	-920-	920	920	920	1 920	920	920	
·45		Cooling after pipe- making	$\exists x b t e   b t (x) = (C   t + 0.86   b t) = 0.9   (b t) = 0.5   b t)$	To sa Alfras Lan	0.4 Alfros   0.0)	0 44 Albas   000	0.45 Alicos   0.0	0.49 ALC 0.0	0.40 Alf. 115 6.0	Alfred Co	Air	Air	Air	041 Alf-	JAC Air 05 GO	Air	7.96 0.05 0.0	1 948 AIP (5 0 0)	Air	Air	Air
50		Steel No.	Setton (5) = (6)	o oscAi o 3	0.02. <b>8</b>   0.2	0.03.0	S.0  d <sup>350 o</sup>	0.04eE 0.3	0.053   6.3	5	Ι		J.	c 550 E.S	Jan. 03.	<del>-</del> -	N 0 034 0.30	19 <b>0</b> 118	d	σ	4
55		Steel pipe No.	) E×bte. ) E×bte.	1 0	2, b	3 0	P1 14	5 101	9	1 2	æ	6	10	÷	12 t		4 m	7 <b>5</b> V	16 = 1 Lapre	17	18

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· .	[0058] Each example of the corrosion rate, and no occurrer superior hot workability and a s of 230°C containing CO <sub>2</sub> . In coccurrence of cracks, thus show corrosion resistance. In particular	uper uper ontra ving a	f pit ior c ist,	ting. como luce	Her sion para dho	res tive wor	it ha istan exa kabi	s be ice ii mple lity, i	en s n a s es or or ex	how eve itsid hibit	n th re c le th	at th orro e sc high	e st sive ope	eel en of	pir vir th	oes onm e pr n rat	of them escential	hes t at ent hus	e e a h inv	xai igh ent ow	mple tem tion ing a	es hav npera exhib redu	ve a ture ited iced	:
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	[0059] After sufficient degassing of 100 kgf (980 N). The ing																							
	of 0.5 in. with a model seamles	ș rol	ling	mill.	H		11	97)	n.	95		-7	~>	-										
	[0060] After the pipe making,										visu	ally.	bbs	ervi	ñġ	the	pre	ese	nce	of	crac	ks in	the	
15	internal and external surfaces of											ł .,		3										· = +
	[0061] The seamless steel pi																							
	under the conditions shown in T piece and subjected to a tensile	abje	4: P	n ar	K-sn	ape	a Ar	ı ier	isile	ięsi Letr	piec	e wa	as la	ike	וו ר	om tron	ine	qu Te	enc	ın-ı: aal	emp	erea	iesi	
	test piece of 3 mm in thickness																							
20	test piece by machining, and w									ıyın	via:	i GV	. i ! !		Ï	E 10	ięg	OIL	y yı	<b>1</b> C 1	1611-1	cnpe	5164	**
	[0062] In the corrosion test, the									st so	olutio	on be	eina	20	%	NaC	:la	aue	ous	ss	olutio	n pla	ced	
	in an autoclave (solution tempe																							
	to keep for 2 weeks.			-			·	i	, <u> </u>					-			•		,					
	[0063] The test piece after th	e င္တိoi	rosi	on te	est v	as v	veig	hed,	anc	the	corı	rosio	nږra	te i	va:	s ob	taiı	ned	fro	m t	he c	liffere	ence	
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	piece after the test was observe	1	che	ckifc	rthe	occ	urre	nce	of p	itting	wit	h a li	pupe	e of	a	mag	nifi	icat	ion	of	10 ti	mes.	The	
	results are shown in Table 4.	100	33	60.0	50.2	2	. <u>2</u> 2	18	Č.		8	To 5	0.05	S										
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[0064] Each example of the present invention exhibited no occurrence of cracks in the steel pipe surfaces, a low corrosion rate, and no occurrence of pitting. Hence, it was shown that the steel pipes of these examples had a superior hot workability and a superior corrosion resistance in a severe; corrosive environment at a high temperature of 230°C containing CO<sub>2</sub>. In contrast, comparative examples outside the scope of the present invention exhibited occurrence of cracks, thus showing a reduced hot workability, or exhibited a high corrosion rate; thus showing a reduced corrosion resistance. When the manufacture conditions were outside the preferred ranges as set forth in the present invention, the strength was reduced and, accordingly, a high yield strength of 654 MPa or more was not achieved.

[0065] After sufficient degassing, each molten steel having a composition shown in Table 5 was cast into a steel ingot of 100 kgf (980 N). The ingot was formed into a seamless steel pipe with an outer diameter of 3.3 in. by a thickness of 0.5 in. with a model seamless rolling mill.

[0066] The hot workability was evaluated by visually observing the presence of cracks in the internal and external surfaces of the resulting seamless steel pipe, as in Example 1.

[0067] The seamless steel pipe was cut into a test piece. The test piece was subjected to quenching and tempering under the conditions shown in Table 6. It was ensured that quenching was performed on each sample at a temperature of its A<sub>C3</sub> transformation point or more, and that tempering was performed at a temperature of its A<sub>C1</sub> transformation point or less: A structure observation test piece was taken from the quench-tempered test piece. The structure observation test piece was etched by aqua regia. The resulting structure was observed with a scanning electron microscope (1000 times), and the percentage of the ferrite phase (percent by volume) was computed with an image analysis system. The percentage of the residual austenite phase was determined by X-ray diffraction.

[0068] An ark shaped API tensile test piece was taken from the quench-tempered test piece and subjected to a tensile test for the tensile properties (yield strength YS, tensile strength TS), as in Example 1. Also, a V-notch test piece (thickness: 5 mm) was taken from the quench-tempered test piece, in accordance with JIS Z 2202, and the Charpy impact test was performed on the V-notch test piece to determine the absorption energy vE<sub>40</sub> (J) at 40°C in accordance with JIS Z 2242.

[0069]—Eurthermore, a corrosion-test-piece of 3 mm in thickness-by-30 mm in width by-40 mm in length was taken from the foregoing quench-tempered test piece by machining, and was subjected to a corrosion test, as in Example 2. [0070] \$\frac{1}{2}\$ in the corrosion test, the test piece was immersed in a test solution being 20% NaCl aqueous solution placed in an autoclave (solution temperature: 230°C, CO<sub>2</sub> gas atmosphere at a pressure of 30 atmospheres) and was allowed to keep for 2 weeks:

[0071] The test piece after the corrosion test was weighed, and the corrosion rate was obtained from the différence between the weight of the lest piece before the lest and that after the lest. The surface of the corrosion test piece after the test was observed to check for the occurrence of pitting with a loupe of a magnification of, 10 times.

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NA I	Th's	\$	S	2 0.001	2 0.001	1 0.002	2 0.001	2 0.001	2 0.001	2-0.001-	-0.02+-0.002-	0.8 (Mg) +	(Si) = 43.5	Cneuching	
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5	1/5	>		0.24	0.21	0.23	0.20	0.25	0.27	0.26	0:31	=(Cr)\+ic	+(Cr)+ riversia bibs	Cooling	
V43 3.	718 5 3H	<u>:</u>	(C	10.027	0.024c	0.018	0.028	0.017	0.024	-0.032	0.035	Expression (j) = $(CI)\sqrt{10.65}$ (Nij) $\frac{1}{10}$ 0.8 (	)/Expression (2) = (Cr) +- (Mo) + 0-3 (Si) 1/0	200	rapile o
; > :	abl	Steel	No.	34	38	ည္က	3D	3E	AF.	36	3H	Exp	<b>6</b> 23		מל ביין

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Workeldy   Corrosion	Table	ם ע														
Pitting   Pitt	Steel	č	Cooling	Que		Tem	pering	Struc	ture	Ten prope	sile	Impact property	Hot workability	Corro resista	sion	
3A         CAIMENER (MRPO DE (MAIT TO DE SESO))         3.0 AIMENER (MRPO DE (MAIT TO DE SESO))         7.1         —         86B         1021         80.2         Good         0.109         Good           3A         AIMENER (MRPO DE (MAIT TO DE SESO))         AIMENER (MRPO DE MAIT TO DE SESO)         4.0 AIMENER (MRPO DE MAIT TO DE MAIT	pipe No.	No.	pipe- making	Тетр (°C)	Cooling	Temp (°C)	Caoling	y quantity vol%	a quantity vol%	YS MPa	TS	Absorbed energy E <sub>-40</sub> J	Crack	Corrosion rate (mm/yr)	Pitting	Remark
36	AMe.	38 ≈		Ü	J ( Air	22501)		7.1		898	1021	80.2	Good	0.109	Good	Example
38		A6			, 5	009	Air	10.9	(i)	_	1047	86.1	_Good _		Good	Example
35   Air   890   Air   550   Air   125   1.5   820   1035   91.2   Good   0.112   Good   G		38	-	890	Air	200	Air	- 6.3	6.0	889	1061	83.4	Good	-0.111+	-Good -	Example
3C         Air         550         Air         12.5         1.5         820         1035         91.2         Good         0.058         Good           3D         Air         550         Air         16.3         19         777         974         95.4         5000         0.102         Good           0.53E         Air         550         Air         16.3         19         77.3         982         17.9         500         0.102         Good         0.102         Good           0.53E         3Air         650         741         227         19         723         982         17.9         500         0.039         Good         0.039         Good         0.039         Good         0.039         Good         0.039         Good         0.039         Good         0.039 <t< td=""><td></td><td><u> </u></td><td>Air</td><td>890</td><td>Ą</td><td>909</td><td>Air</td><td>11.2</td><td>0.7</td><td>847</td><td>1030</td><td>85.7</td><td>Good</td><td>0.112</td><td>Good</td><td>Example</td></t<>		<u> </u>	Air	890	Ą	909	Air	11.2	0.7	847	1030	85.7	Good	0.112	Good	Example
3D         Air         550         Air         16.3         19         771         974         95.4         200d         0.102         Good           0 3E         3Air         890         Air         550         Air         22.7         580         771         95.4         35.9         350.0         0.039         600           0 3D         3Air         560         Air         26.3         0.04         50         1.96         1.00	A5	ည္က	Air	.069	Air	-550-	Ą	12.5	1.5	820	1035	91.2	Good	0.058	Good	Example
0 3 3E         3 4 r 3         890   Air 3 560   Air 3 560   Air 3 580			Air	. 890	Alc	550	Air			3	974	95.4	Good	0.102		Example
10   3D   13   4   10   10   10   10   10   10   10	17	3E	5 1		AF.	550	Air	22.7	3 B	723	ا ليو	95.9		0.039	Good	Example
0 25ge (3.1 Air 3 )         8902 (3.1 Big)         0 Air 3 (3.2 Big)         1 Big)         <	8	30	1	890 1	Pi	ੂ <mark>650</mark> ੰ		26.3	1.04 Leo.	ं <sub>634</sub>	915	104.3		50,105	Good	Example
3G         Air         890         Air         500         37.2         85.4° 0.0 8989         414.48         35.4         35.0         36.096         Good         42.3         Bad         30.096         Good         42.3         Good         42.3         Good         42.3         Good         42.3         Good         42.1         42.2         42.3         Good         42.1         42.2         42.3         Good         42.1         42.2         42.3	A.9		S. Ar. 3.	890	1	, 950 t	- F	29.6	0 CO P	299 c	309€	132-107.8°	Poop (	0.037	Pog S	Example
3G Air 890 Air 540 Air 7.3 2.7 827 1095 79.3 Good 2 N. & Bad 3 1	A10	. 3F	3v Air 0 3.		<b>□</b>	, 00S.C	2.5 AIR !!	3.2	0.0 Sa	3 <b>686</b> e	1149	25 ⁴ 42.3	Bad	960 <u>.0</u>	Good	Comparative Example
3H Air 890 Air 450 Air 949 1018 37.5 Good 0.124 Good	A11	36	Air	980	Air		्. <b>Air</b> े	Lit.		875	1095	79.3	Good	0.7.1.79 N	ло <b>ред</b> ідк	Comparative Example
3A Air 890 Air 450 Air 949 1018 37.5 Good 0.124 Good	A12	3H	Air	890	Air	540	Air	7.3	2.7	827	1046	0.77	Good	0.150	Good	Comparative Example
	A13	₩	Air	980	Air	450	Air	1	1	949	1018	37.5	Good	0.124	Good	Example

 $\gamma$ : residual austenite,  $\alpha$ : ferrite (5)

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[0073] Each example of the present invention exhibited no occurrence of cracks in the steel pipe surfaces, a low corrosion rate, and no occurrence of pitting, hence it was shown that steel pipes of these examples had a superior hot workability. In addition, their structure containing 5 to 25 percent by volume of residual austenite phase, or further containing 5 percent by volume of less of territe phase leads to a superior corrosion resistance in a severe corrosive environment at a high temperature of 230°C containing CO<sub>2</sub>. Furthermore, the strength is as high as 654 MPa or more in terms of yield strength YS and the loughness is as high as 60°U or more in terms of absorbed energy at 40°C.

[0074] In contrast, comparative examples outside the scope of the present invention exhibited occurrence of cracks, thus showing a reduced not workability, of exhibited a high corrosion rate, thus showing a reduced corrosion resistance. When the manufacture conditions were outside the preferred ranges as set forth in the present invention, the strength was decreased and accordingly, a highlyfeld strength of 654 MPa or more was not achieved a pure and leads only although the set of the preferred range as a surrangual industrial Applicability.

[0075] According to the present invention, a high-strength martensitic stainless steel pipe for oil country Tubular goods can be manufactured at a low cost with stability which has a sufficient corrosion resistance in severe, corrosive environments at high temperatures containing CO<sub>2</sub> or Cl<sup>-</sup> or which has a high toughness in addition to such a sufficient corrosion resistance, thus producing particularly advantageous industrial effects.

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20 Claims

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(3)

1. A corrosion-resistant stainless steel pipe for oil country tubular goods having a steel composition comprising on a mass basis:

0.5% to 3.5% of Cu;

0.05% or less of Al;

0.05% of less of V; stretces at the control of the co

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wherein the composition satisfies expressions (1) and (2):

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30. A method tor manufactions a strictoss steer park to obtain the problem according to each and 0.0 turns. The method tor manufactions as strictoss steer part of the method to make the consisting of 0.2 to 0.0 turns of 0.2 to 0.0 turns of 0.2 to 0.0 turns of 0.2 turns of 0.2

where Cr, Ni, Mo, Cu, C, Si, Mn, and N represent the respective contents thereof on a mass% basis. small to any one of grantended according to any one of Claustic Models according to any one of Claustic Models according to the order of the content of the order of the orde

2. A stainless steel pipe for oil country tubular goods according to Claim 1, wherein the composition further comprises at least one element selected from the group consisting of 0.20% or less of Nb and 0.30% or less of Ti on a mass through basis; hallough through the oil sour less as the standard trades through the control of source through the control of the control of source through the control of the con

ാ 3;നം Arstairiless steel ipipe forbill codintry tubular goods according to Claim 1962; wherein the fcomposition further യെട്ടാരാണ് prises at least one element selected from the group consisting of 0.20% or less of Zr,10:01% or less of B, and see 13.0% of less of W on a mass basis of 2 and a see 13.0% of less of W on a mass basis of 2 and a see 13.0% of less of W on a mass basis of 2 and a see 13.0% or less of W on a mass basis of 2 and a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which was a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which we have a see 13.0% or less of which will be seen as a see 13.0% or less of which which we have a seen a see 13.0% or less of which we have a seen a see 13.0% or less of which we have a seen a see 13.0% or less of which we have a seen as a seen a seen as a seen as a seen as a seen a seen a seen as a seen a seen a seen a seen a seen as a seen a seen a seen a seen a seen as a seen a seen

4. A stainless steel pipe for oil country tubular goods according to any one of Claims 1 to 3, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.

5	5. A stainless steel pipe for oil country tubular goods according to any one of Claims 1 to 4, wherein the structure the attended includes 5 to 25 percent by volume of a residual austenite phase and the balance being a martensite phase.  6. A stainless steel pipe for oil country tubular goods according to any one of Claims 1 to 4, wherein the structure thereof includes on a volume basis 5 to 25 percent by volume of a residual austenite phase, 5 percent by volume or less of a ferrite phase, and the balance being a martensite phase.	
10	Table a contemporary besiditing numbered to some state of the second and the second and the second and the state of the second and the state of the	
15	at don't (0.05%) or, less of, C; do last as a master of the second of the result of the second of th	
20	0.005% or less of S; 14.0% to 18.0% of Cr; 5.0% to 8.0% of Ni;	
	1.5% to 3.5% of Mo;  a no gold 0.5% to 3.5% of Culpert, a colored and a color of the colored and to see the se	
25	0.01% to 0.15% of N; 0.006% or less of O, and the balance being Fe and incidental impurities, wherein the composition satisfies expressions (1) and (2):	
30	$Cr + 0.65Ni + 0.6Mo + 0.55Cu + 20C \ge 18.5 \frac{2.79 \times 30 + 0.0700 \times 0.070}{0.76 \times 9.070 \times 9.070} $ $\frac{2.79 \times 9.07 \times 9.070}{0.76 \times 9.070} \times 9.070$ $\frac{2.79 \times 9.070}{0.76 \times 9.070} \times 9.070$	
	Cr + Mo + 0.3Si - 43.5C - 0.4Mn - Ni - 0.3Cu - 9N $\leq 11^{\frac{10}{11}}$ $\frac{3}{12}$ $\frac{3}{1$	
35	where Cr, Ni, Mo, Cu, C, Si, Mn, and N represent the respective contents thereof on a mass% basis.  190,303.00 (a mass% basis.  190,303.00 (a mass% basis.)  8. A method for manufacturing a stainless steel pipe for oil country tubular goods according to Claim 7, wherein the	
	composition further comprises at least one element of 0.20% or less of Nb and 0.30% or less of Ti on a mass basis.	
40	9. A method for manufacturing a stainless steel pipe for oil country tubular goods according to Claim 8, wherein the quenching includes heating to a temperature in the range of 800 to 1100°C and cooling to room temperature at air-cooling speed or more, and the tempering is performed at a temperature in the range of 500 to 630°C.	
45	10. A method for manufacturing a stainless steel pipe for oil country tubular goods according to any one of Claims 7 to 9, wherein the composition further comprises at least one element selected from the group consisting of 0.20% or less of Zr, 0.01% or less of B, and 3.0% or less of W on a mass basis.	,
50	11. A method for manufacturing a stainless steel pipe for oil country tubular goods according to any one of Claims 7 again to 10, wherein the composition further comprises 0.0005% to 0.01% of Calong mass basis, as asotropic Along the area of Timese in 6008.0 and dMin sequentially a country tubular goods according to any one of Claims 7.	
55	12. A method for manufacturing a corrosion-resistant seamless stainless steel pipe for oil country tubular goods, comprising the steep of: forming a steel pipe from a steel pipe material having a composition by hot working; cooling so the steel pipe to room temperature at air-cooling speed or more, or quenching the steel pipe by further heating to a temperature of the A <sub>C3</sub> transformation point thereof or more and cooling to room temperature at air cooking speed or more; and then tempering the steel pipe at a temperature of the A <sub>C1</sub> transformation point thereof or less, wherein the composition comprises on a mass basis:	,
	This control of the Wilder of the Mark Control of the Control of t	

	0.50% or less of Si;	
	~ 0.20% to 1.80%.of Mn; ~	
	0.03 or less of Parkage amounted 120 YET W. Bod Lee Bis and See 1	
	0.005% or less of S <sub>1</sub> 100	
5	14.0% to 18.0% of Cr; 10 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
	5.0% to 8.0% of Ni;	
	! 1.5% to 3.5% of Mo;	
	0.5% to 3.5% of Cu;	
	0.05% or less of Al; Optional Pulsar Charifficator (PC) or to tech actional classification and IPC	
10	0.20% or less of V;	
	0.01% to 0.15% of N; electron contribute of all transfer not contributed bearing and bearing or between many all a	
•	0.006% or less of O, and (45.96.55) 303 8635 3 3 3 3 4	
	the balance being Fe and incidental impurities, and wherein the composition satisfies expressions (1) and (2	١.
	and ballation boding to and moreonical imparities, and whorein the composition satisfies expressions (1) and (2)	)٠
15	Dorne continue see what attact tipe, pair again doesn expand to the extent the good desquests are included to be feeless a create	
,-	25 State and Tenter Cht. 0.65Ni + 0.6Mo. + 0.55Cu + 20C ≥ 18.5 cm (1.20 state square (1.20 state square control square contro	);
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	tage a line for the latest three made a latest end after in latest in the forest functional and the states of the second of the	٦.
20		′′
20	When Co Ni Ma Cu C Si Ma and Name and the second the second time of th	
	where Cr, Ni, Mo, Cu, C, Si, Mn, and N represent the respective contents thereof on a mass% basis.	
	C. DUCUMENTS CONSIDERED TO BE RELEVANT	_
	13. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to Claim 1	2,
	wherein the composition further comprises at least one element of 0.20% or less of Nb and 0.30% or less of Ti c	חנ
25	a mass basis. 12P 2002-4009 A (Mavaeshi Steel Corp. 1. disad asam a new fig. 2002 4000 4000 02)	
	+ + + + + + + + + + + + + + + + + + + +	
	14. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods-according to Claim 1	3,
	wherein the quenching includes heating to a temperature in the range of 800 to 1100°C and cooling to room	m
	temperature at air-cooling speed of more, and the tempering is performed at a temperature in the range of 500	0
30	.0°06 28 February, 2001 (28.02.02)	
	Full text	
	15. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one	of
	Claims 12 to 14, wherein the composition further comprises at least one element selected from the group consisting	
	of 0.20% or less of Zr, 0.01% or less of B, and 3.0% or less of W on a mass basis.	ıg
		ıg
35		ng
33	16. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one	ng
	16. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.	ng
	16. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.	ng
	16. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.	ng
. 40	16. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.	ng
	16. A method for manufacturing a seamless stainless steel pipe for oil country tubular goods according to any one Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.  Name (functional seasons) 2 x 86 to definition of initial seasons and additional control of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any one of the country tubular goods according to any other country tubular goods according	ng
	Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.	ng
	Claims 12 to 15, wherein the composition further comprises 0.0005% to 0.01% of Ca on a mass basis.  Anne glocult tradegrand [	ng
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